

Technical University of Denmark



Strip detector for nanoscale resolution

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Publication date:
2009

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Citation (APA):

Olsen, U. L., Schmidt, S., Poulsen, H. F., Yvind, K., & Ottaviano, L. (2009). Strip detector for nanoscale resolution [Sound/Visual production (digital)]. Detektor Workshop, Risø (DK), 27 Feb., 01/01/2009

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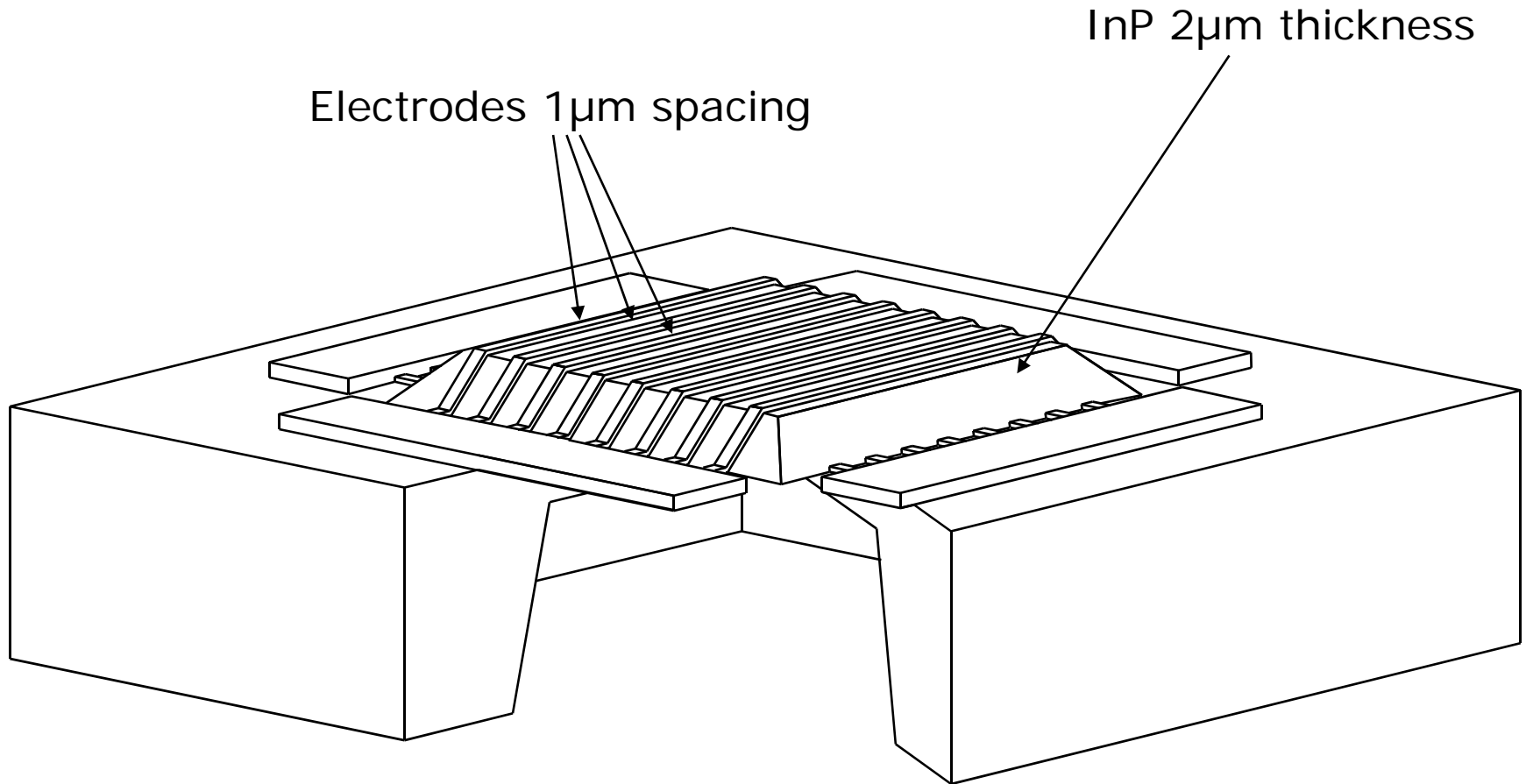
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The 3D x-ray nano-detector

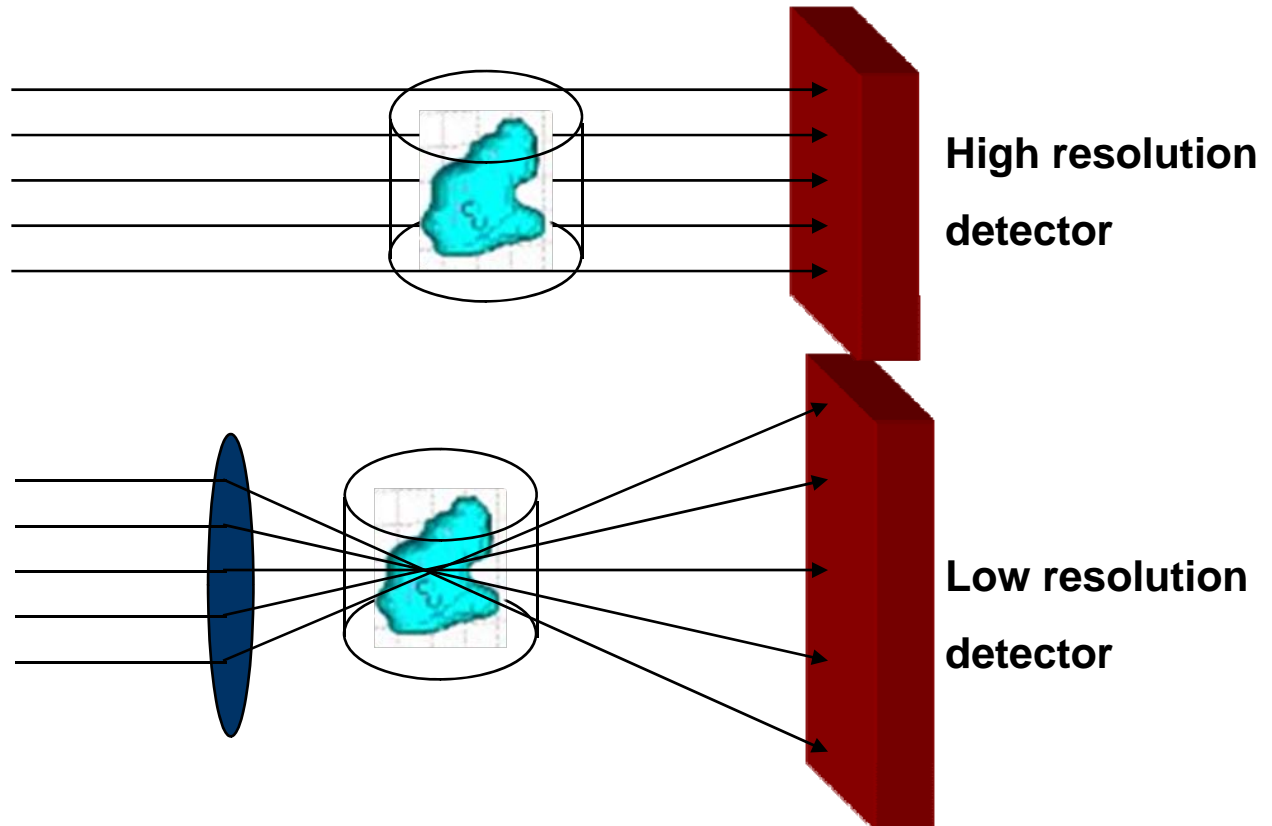
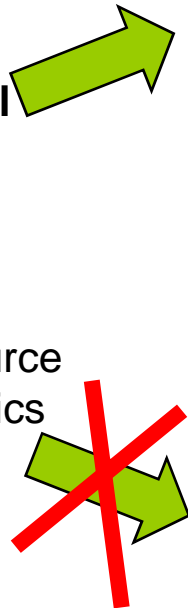
Risø DTU: Ulrik Lund Olsen, Søren Schmidt, Henning Friis Poulsen

DTU Photonics: Kresten Yvind, Luisa Ottaviano



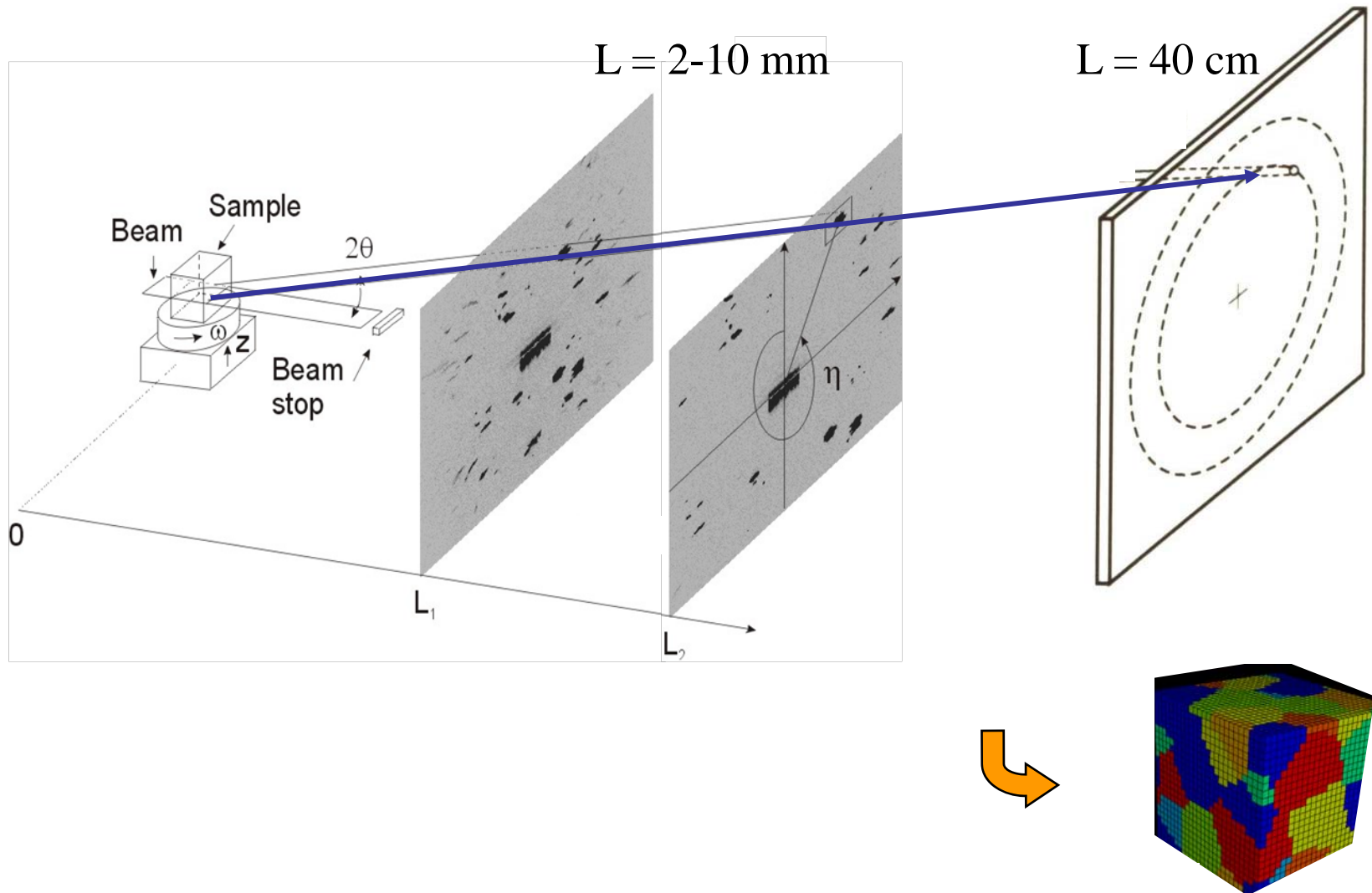
High resolution detectors - why

**experimental
conditions:**
white beam
high energy
tight space
non-ideal source
non-ideal optics



3DXRD set-up @ ID11, ESRF

30-80 keV x-rays

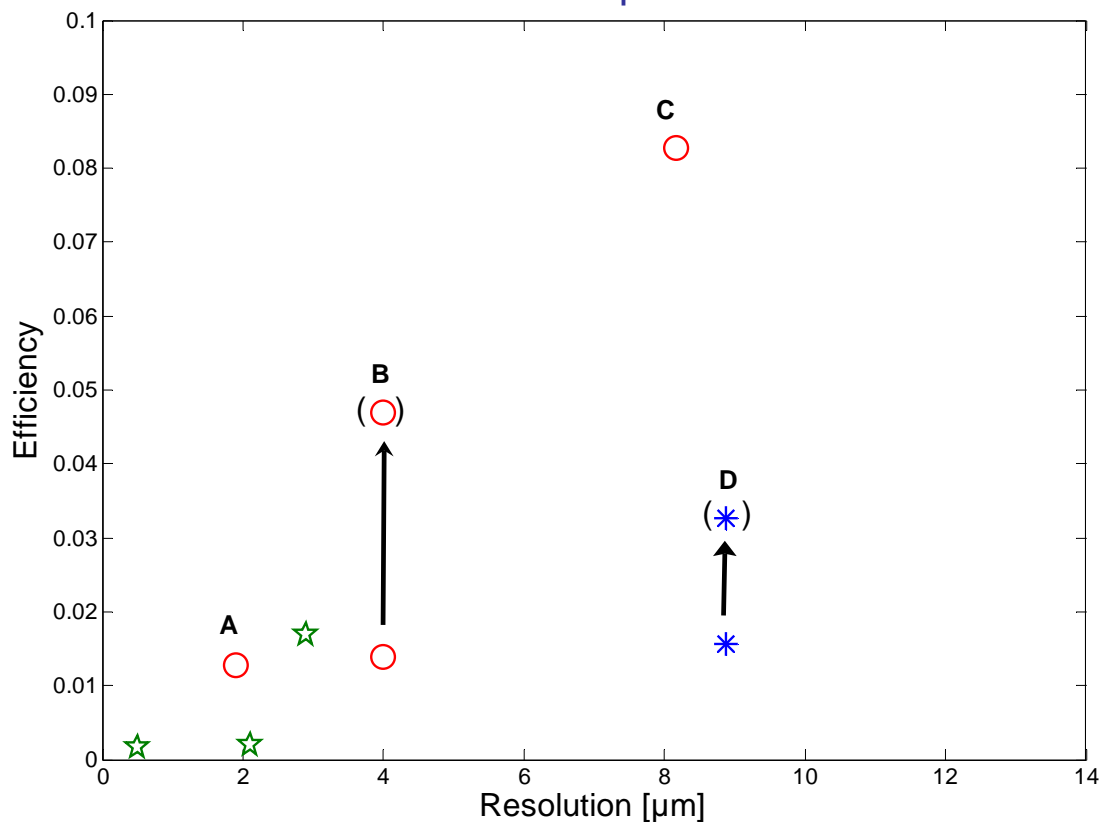


Structured scintillator project

Collab with: KTH, Sweden: X. Badel, J. Linros

ESRF: T. Martin, V. Honkimaki, M. diMichiel

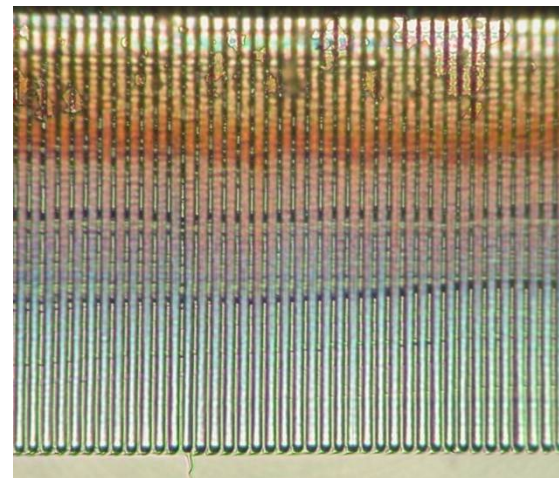
structured scintillators / planar scintillators



Limitation 1 μm

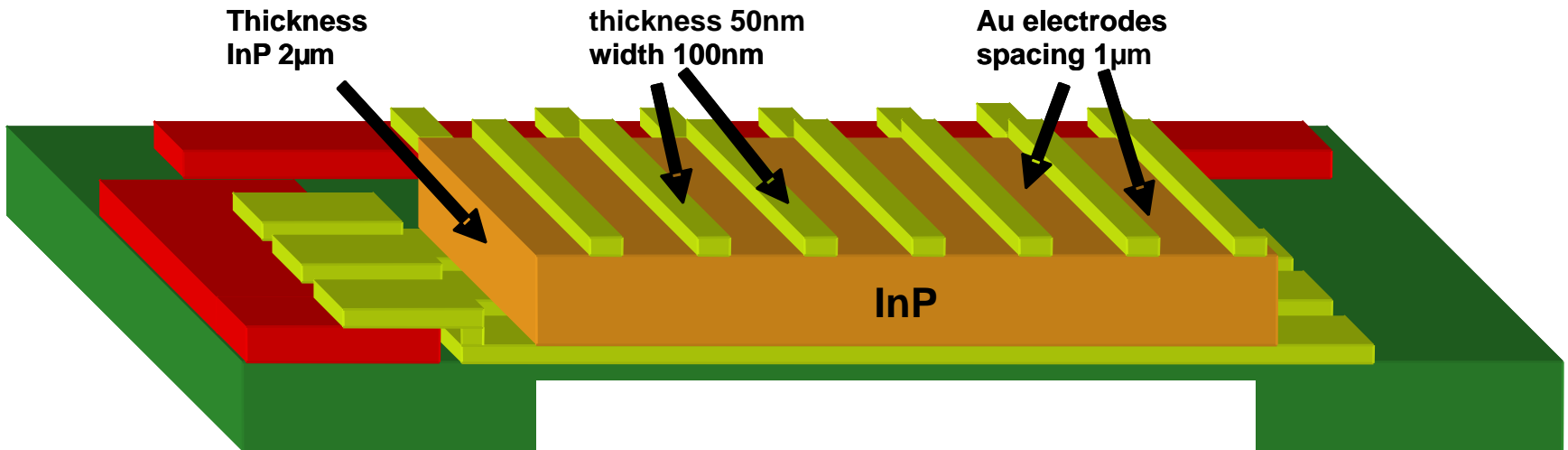


Nanodetector



sensor design

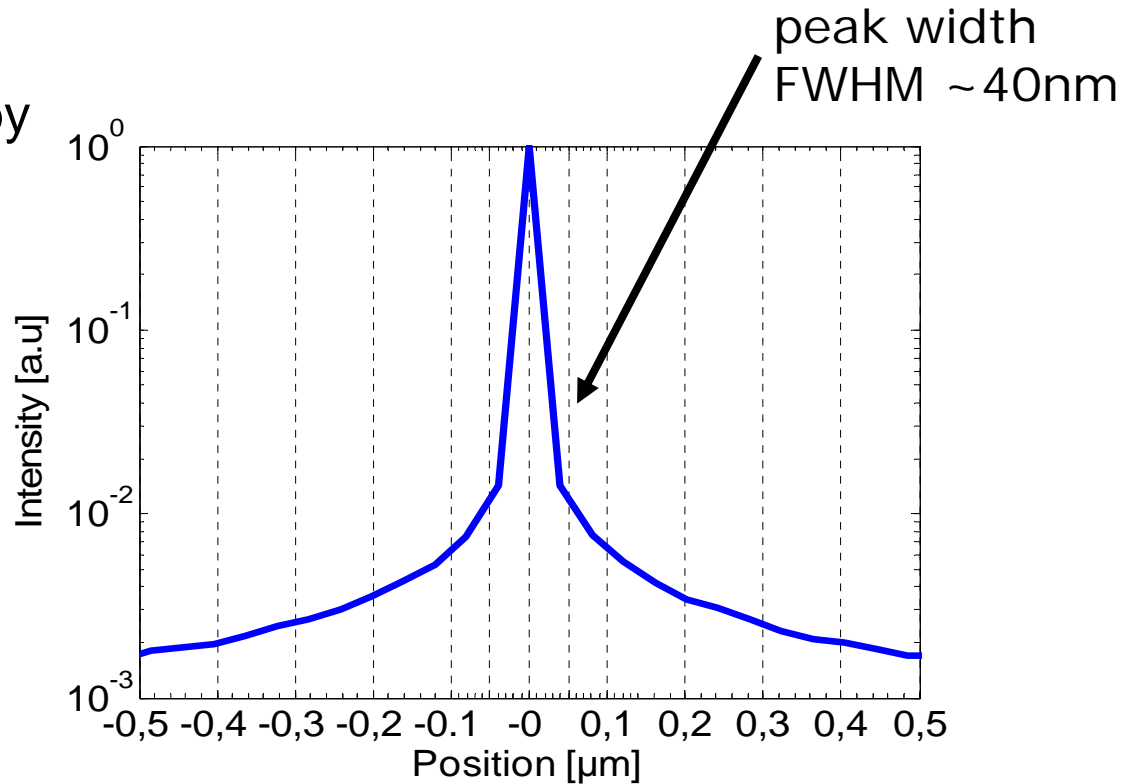
- 1mm^2 active area
- $1\mu\text{m}$ pitch of electrodes
- 2 orthogonal sets of parallel electrodes
- Electrode dimensions $\sim 50\text{nm} \times 100\text{nm} \times 1\text{mm}$
- Sensor thickness $2\mu\text{m} \rightarrow 10\% @ 10\text{keV}$



1st order simulation of spatial resolution –e/h pair generation

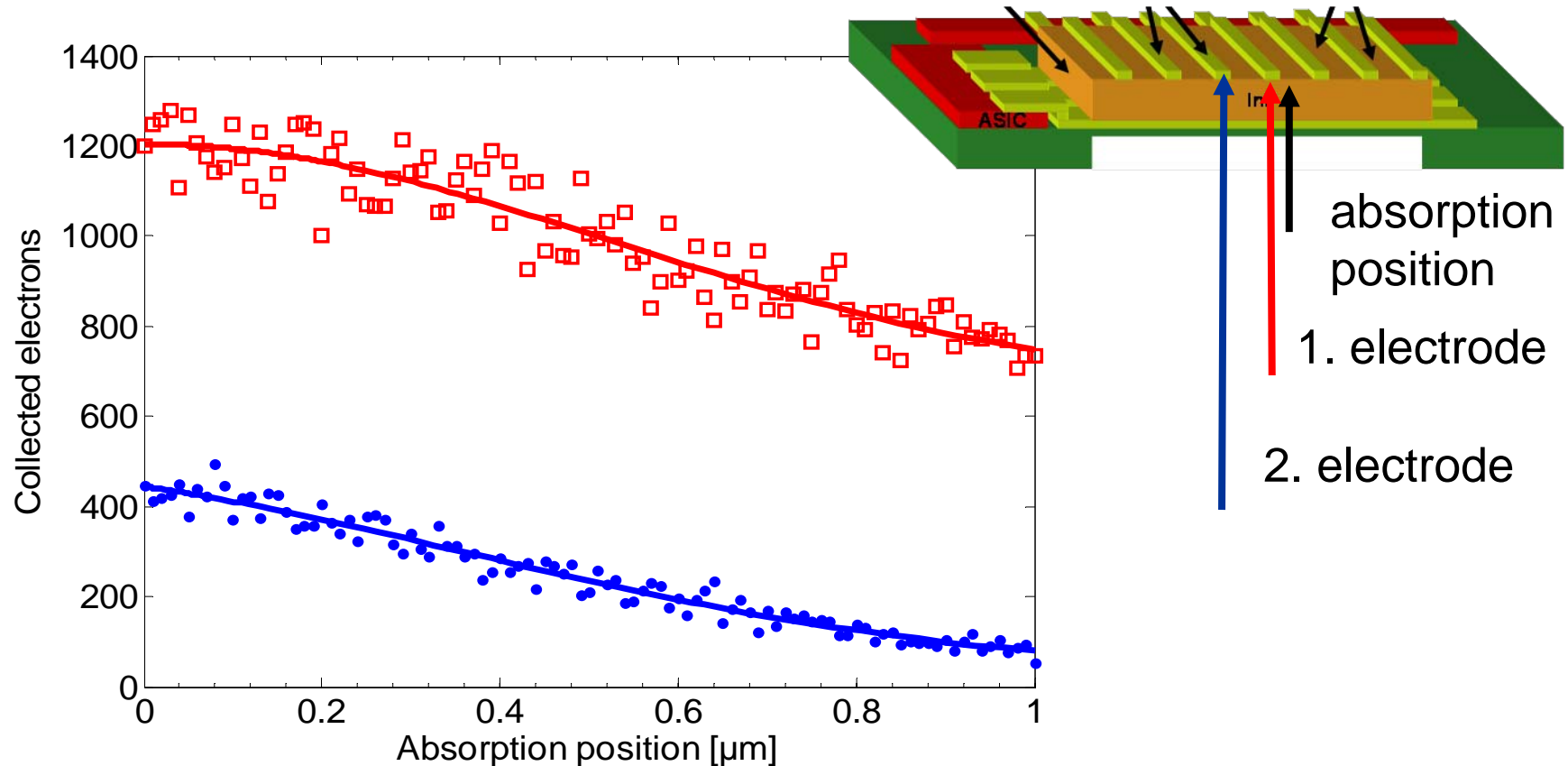
X-ray absorption simulated by MCNP.

2 μ m thick sensor
10 keV X-rays



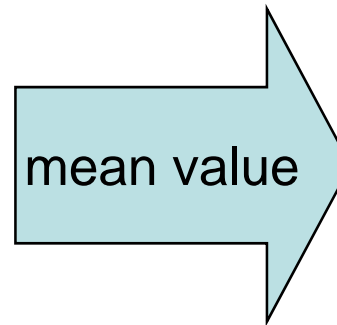
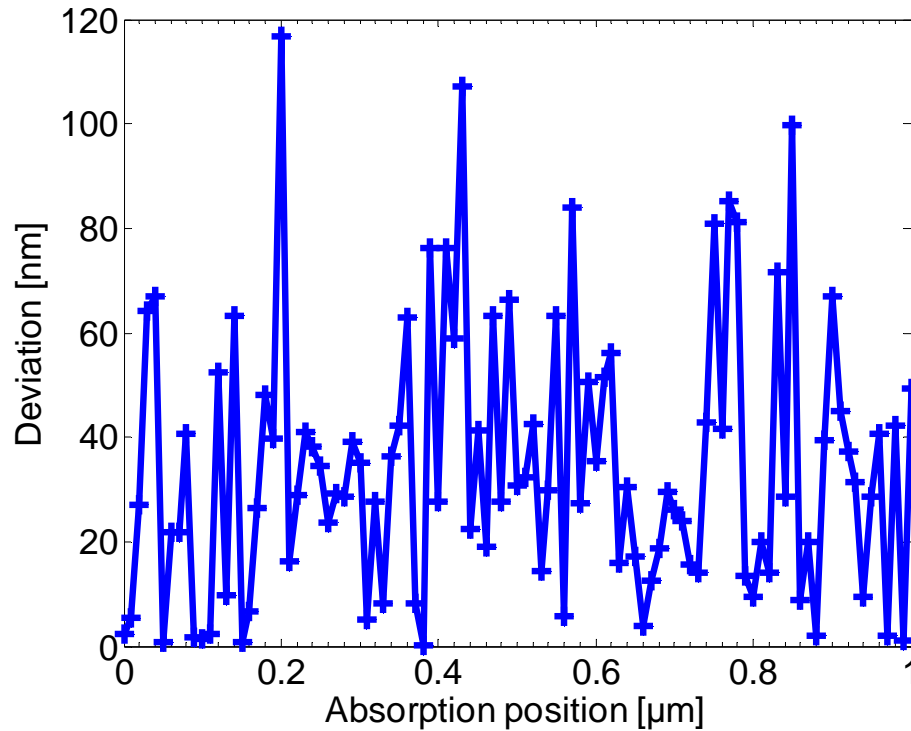
Absorbed Energy Vs Distance from X-ray hit (average of 750.000 photons)

1st order simulation of spatial resolution - drift/diffusion



10keV X-ray ~ 2500 e/h pairs

1st order simulation of spatial resolution - findings



35nm+/- 25nm

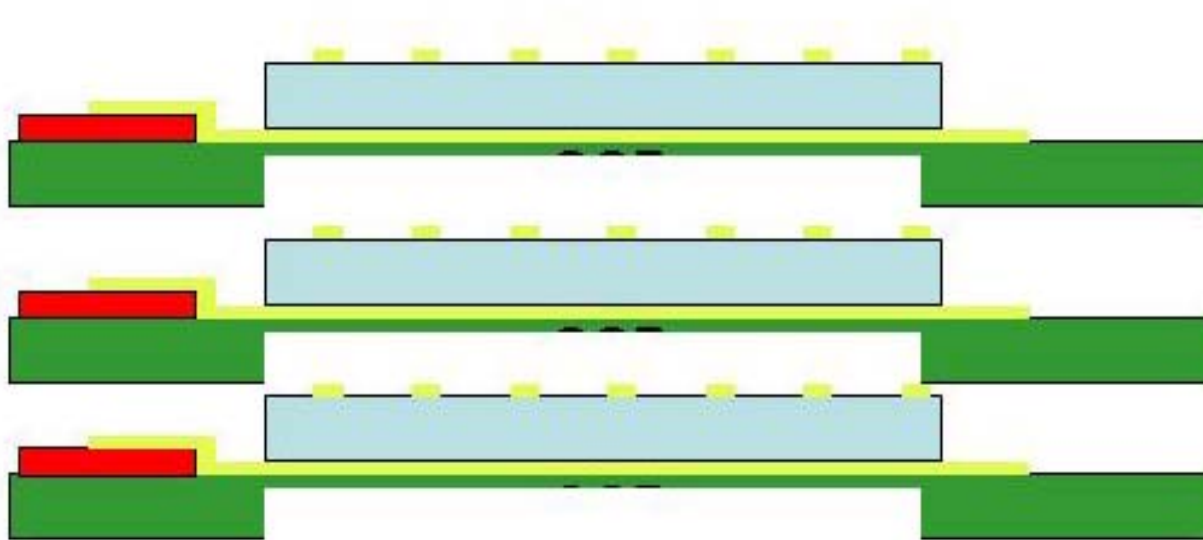
Assumptions:

noiseless electronics

no recombinations

No design optimisation like AC coupled auxiliary electrodes

3D configuration for higher energies



- multiple layers increase efficiency
- capability of raytracing algorithms (no parallax problem!)
- options for superresolution
- possibilities for more accurate sample alignment

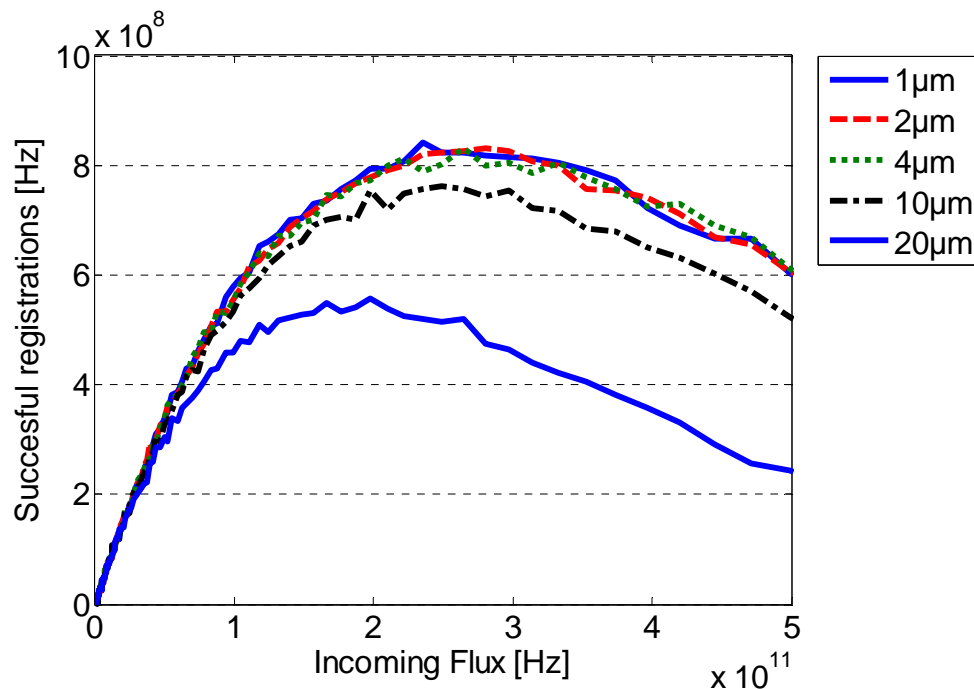
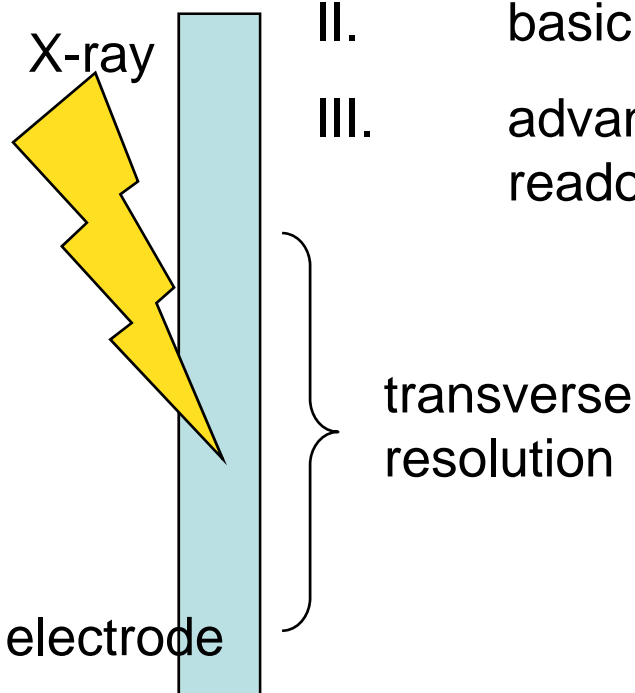
Throughput

Present ~10k photons/sec on serial 10Mhz read-out

Further development in read-out electronics divided in phase II and III

II. basic parallel electronics: ~5M photons/sec

III. advanced 2D registration using pulse shape or double readout.: increase by 2 orders of magnitude



Timing

Phase I: proof-of-concept

proof of concept funding 1/1 08 – 31/6 09, 2 manyear

Aim: demonstrate 100 nm resolution.

Phase II: 5 MHz 2D detector

Deliverables:

- A prototype detector
- Test of resolution, imaging, stability, throughput
- A report on electronics for Phase III

Manpower: ~ 5 manyears * 3 years

Timing: start 2009

Phase III: Detector for XFEL

- Advanced electronics: delay-lines/pulse-shape analysis
- 3D detector

Conclusions

- lens-less single photon detector
- 100nm resolution
- infinite dynamic range
- 1keV-50keV photon energies